The Origination and Evolution of Radio Traffic Analysis

The Period between the Wars

[redacted]

There is no absolute truth in history. All history is an interpretation of "facts," some selected and some rejected. But facts are not factual at all, they are a series of accepted judgments. Nevertheless, we can view the past and achieve an understanding through the eyes of the present and progressively emerging future.

History is about those who achieve something, either through an apparent success or an evident failure. Achievers are those who have had an impact in a way which sets them apart from the average or the common. This article is a "history" about some men who confronted signals intelligence and traffic analysis, and who made a difference.

Traffic analysis in the United States was created as a recognized discipline of signals intelligence by the U.S. Navy during the period between the two world wars. The Japanese Grand Fleet Maneuvers of 1930 and 1933 provided the incentive and Lieutenant Joseph N. Wenger, USN (who served as first vice director of the National Security Agency in 1952–53), merits recognition as the instigator of traffic analysis activities during those times.

Naval maneuvers by the Japanese in 1930 astounded the U.S. in more ways than one: the exercises demonstrated a scope and depth of Japanese ambitions in the Pacific heretofore unimagined and shocked the Navy into realizing the necessity for tactical intelligence in support of the U.S. fleet. In 1933, Wenger and the Navy responded to the challenge. They recognized the need for immediate and accurate intelligence on the movement and actions of the Japanese navy. It was Wenger's perception that a study of the external features of radio traffic could supply vital intelligence to the fleet even without a successful cryptanalytic breakout of the content of that traffic.

The Navy seized upon the Japanese maneuvers of 1933 to establish the value of radio traffic analysis to fleet operations. An experiment conducted during the maneuvers, focused on exploiting Japanese radio traffic, was imminently successful and was the single most important event in the development of traffic analysis for the United States between the wars. Wenger, one of the Navy's first cryptanalysts, developed a plan in the spring of 1933 to exploit Japanese operational naval communications during the summer maneuvers. He developed rudimentary TA techniques which helped to identify and locate communications subscribers. This produced immediate intelligence. The development of traffic analysis during this period subsequently proved to be of inestimable value to the United States during World War II as will be seen in later articles.

This article is the second in a series describing the development of traffic analysis. It traces its evolution from the end of World War I up to the beginning of the Second World War.[1]

1. See "Origination and Evolution of Radio T/A: Part I, World War I Era," published in the Spring 1987 issue of the *Cryptologic Quarterly*, for a description of traffic analysis during World War I.

INITIAL DEVELOPMENT AND THE JAPANESE FLEET MANEUVERS OF 1927

Participation by the U.S. Navy in World War I was too limited for any degree of Sigint development, but interest was stimulated by successful British efforts.[2] During that war, the Navy relied on the British Admiralty for intelligence information in Europe.[3] In the spring of 1920, however, naval intelligence financed a series of break-ins by the FBI at the Japanese consulate in New York. These "black bag" jobs were repeated several times in the 1920s and were intended to acquire evidence of subversive activities in the United States. The unexpected result was the acquisition of the complete Japanese fleet code book, photographed during several visits to the consulate.

With this code in hand, the Navy in 1924 established an intelligence unit within the Office of Naval Communications and named it OP-20-G, or the "Research Desk." OP-20-G had, as its initial task, to exploit the principal code of the Imperial Navy – the cryptanalysts called it the "Red Code," after the color of the original books.[4] (The Japanese used this code until early 1931.)

Possession of the Red Code precipitated the establishment of a network of intercept stations in the Pacific to acquire radio traffic for the cryptanalysts – the first station was at Shanghai in 1924.[5] Prior to this time, Washington received only a handful of Japanese messages at irregular intervals sent by naval communicators or radio hams on their own initiative.[6] The only U.S. Naval intercept units in 1924 were at the U.S. consulate in Shanghai and some limited intercept capability aboard the USS *Huron*. The unit at Shanghai was begun with self-trained general communications service operators copying Japanese traffic in their spare time.

In Washington Lieutenant Laurance F. Safford, head of OP-20-G, established the primary course in cryptanalysis for the Navy.[7] The first solution of Japanese cipher, using the Red Book, was accomplished in 1926 by naval cryptanalysts.[8] By 1927, the Navy had established stations in Shanghai, Beijing, and Hawaii. Other stations were organized at Guam in 1929 and in the Philippines in 1930.[9]

2. David Kahn, *The Codebreakers: History of Secret Communication* (New York: Macmillan, 1967), p. 387.
3. SRH 149, "A Brief History of Communications Intelligence in the United States," Captain Laurance F. Safford, USN (Ret), 21–27 March 1952, pp. 3–4. The Code and Signal Section of Naval Communications was involved in compilation, production, distribution, and accounting of codes and ciphers during WW I. See also Patrick Beesly, *Room 40: British Naval Intelligence 1914–1918* (New York: Harcourt Brace Jovanovice, 1982), pp. 245–46, 248. One of the main conduits for Room 40 Sigint to the U.S. was via Admiral William S. Sims. Sims arrived in London immediately after declaration of war to assume command of U.S. Naval forces in Europe. He established an excellent relationship with British navy Captain "Blinker" Hall, head of British naval Sigint during World War I. Hall shared with Sims daily intelligence about operations of the German fleet. Hall, however, did not share cryptographic expertise with the U.S. nor did he help the U.S. establish its own Room 40 equivalent since he thought the U.S. did not have anything to offer the British. The U.S. Navy did, however, supply the British with copies of diplomatic cables from U.S. telegraph organizations.
4. Rear Admiral Edwin T. Layton, *And I Was There: Pearl Harbor and Midway – Breaking the Secrets* (New York: William Morrow and Company, 1985), pp. 31–32. Also, SRH 149, pp. 4–6. The task of OP-20-G in those early years was to establish intercept stations in the Pacific, create a cryptanalytic bureau in Washington, train personnel, and plan for the future. OP-20-G was succeeded by Communications Security Group in 1938.
5. SRH 355, "Naval Security Group History to World War II," Captain J. S. Holtwick, Jr., USN (Ret), June 1971, pp. 36–38.
6. Ibid., p. 39.
7. One of Safford's first students was Ensign Wenger.
8. Layton, *And I Was There*, pp. 32–36.
9. SRH 355 contains the history of the Navy's intercept stations in the 1920s and 1930s.

CAPT Laurance F. Safford, USN

The development of the Navy Comint organization now moved forward rapidly. Lieutenant Commander Ellis M. Zacharias, the officer-in-charge at Shanghai in 1926, used the USS *McCormick* to test the feasibility of regularly intercepting traffic from afloat during that year. In 1927, Zacharias, aware that major Japanese maneuvers were in progress, convinced the CNO and Commander-in-Chief Asiatic Fleet (CINCAF) to use the USS *Marblehead* and ground-based stations to intercept Japanese fleet communications. He returned to Shanghai in late 1927 and wrote the first comprehensive intelligence report on the Combined Japanese Fleet in action.[10]

The first phase of the 1927 maneuvers extended from 10 to 20 October. The USS *Cincinnati*, cruising off the southern tip of Korea, intercepted tactical signals and general service traffic from a position about 400 miles from the maneuver area. Most of the traffic was encoded but the submarine traffic was in plain language. Sixty tactical calls used by the Japanese were recorded by the *Cincinnati*. According to Zacharias, "by means of the address in the messages, (it was) possible to identify the majority of (the tactical calls)" – but only after the maneuvers were completed.

During the second phase, the USS *Marblehead*, steaming between Shanghai and Nagasaki and then to Kobe via the inland sea, intercepted Japanese fleet communications from 20 to 30 October. The Navy quickly realized that the ship's operators had no knowledge of Japanese code or procedures and therefore could not identify and record callsigns. DF was atrocious (a 10 degree error was routine) and the receiving sets were not calibrated. The Navy did, however, copy about 100 pages of encoded tactical traffic for the cryptanalysts.[12]

Zacharias, a Japanese linguist, observed that

> tactical calls (are) allocated alphabetically and numerically according to types. Addresses always precede (the) body of messages (and) appear to be parts of the names of ships or stations to which addressed. Various departments (can be identified) by KA (Commanding Officer) (and) CHI (Commandant). (We) identified the (RED – 3rd Fleet) flagship address (IN) since this ship tuned frequencies for the rest of the ships. Later (this was) corroborated by work of IN with units. Japanese used too much calling through whole lots of tactical calls to see if (there was) any traffic. When a tactical call didn't answer, the Japanese switched to international calls and signatures which helped identify tactical calls.[13]

The final report from CINCAF for the 1927 maneuvers concluded:

1. Intercept from the ships was valuable in that a tremendous amount of traffic was obtained which would assist cryptanalysis.
2. The Japanese radio operators were undisciplined regarding radio procedures.
3. Due to central control being exercised from Tokyo, radio silence was impossible.
4. The Japanese system of codes, tactical calls, and addresses would not allow for radical changes without disrupting their communications.
5. The U.S. Navy had no effective DF to track vessels.
6. The Japanese did not use HF communications.[14]

10. Ibid., pp. 55–58.
11. SRH 320, "Various Reports on Japanese Grand Fleet Maneuvers 1927–1929," p. 1. This manuscript contains a report from the Asiatic fleet flagship (USS *Pittsburgh*) at Shanghai dated 28 November 1927 on the 1927 maneuvers and various attache reports.
12. Ibid., pp. 1–2.
13. Ibid., p. 3.
14. Ibid., p. 8.

Zacharias recommended to the CNO and CINCAF that the U.S. Navy (1) cover future Japanese maneuvers, (2) train operators to intercept Japanese communications, and (3) recruit linguists and cryptanalysts to assist in identifying the traffic.[15] At this time, identification and analysis of traffic was accomplished in a very limited fashion by either the operator, the linguist, or the cryptanalyst – there was no consideration given to a separate Sigint discipline for traffic analysis. For the Navy at least, that was not to come until the maneuvers of 1930.

THE JAPANESE GRAND FLEET MANEUVERS OF 1930

In a report dated 22 July 1931 to the Director of Naval Communications,[16] Lieutenant Joseph Wenger commented that most of the information about the beginning of the 1930 maneuvers – that the Japanese Fleet set sail for the South Seas on 15 May and returned on 19 June 1930 – was based on observations by the American naval attaché in Tokyo. Up until this time, the Japanese had regularly informed our attaché about the fleet maneuvers, but no movement report was issued on the 1930 exercises.

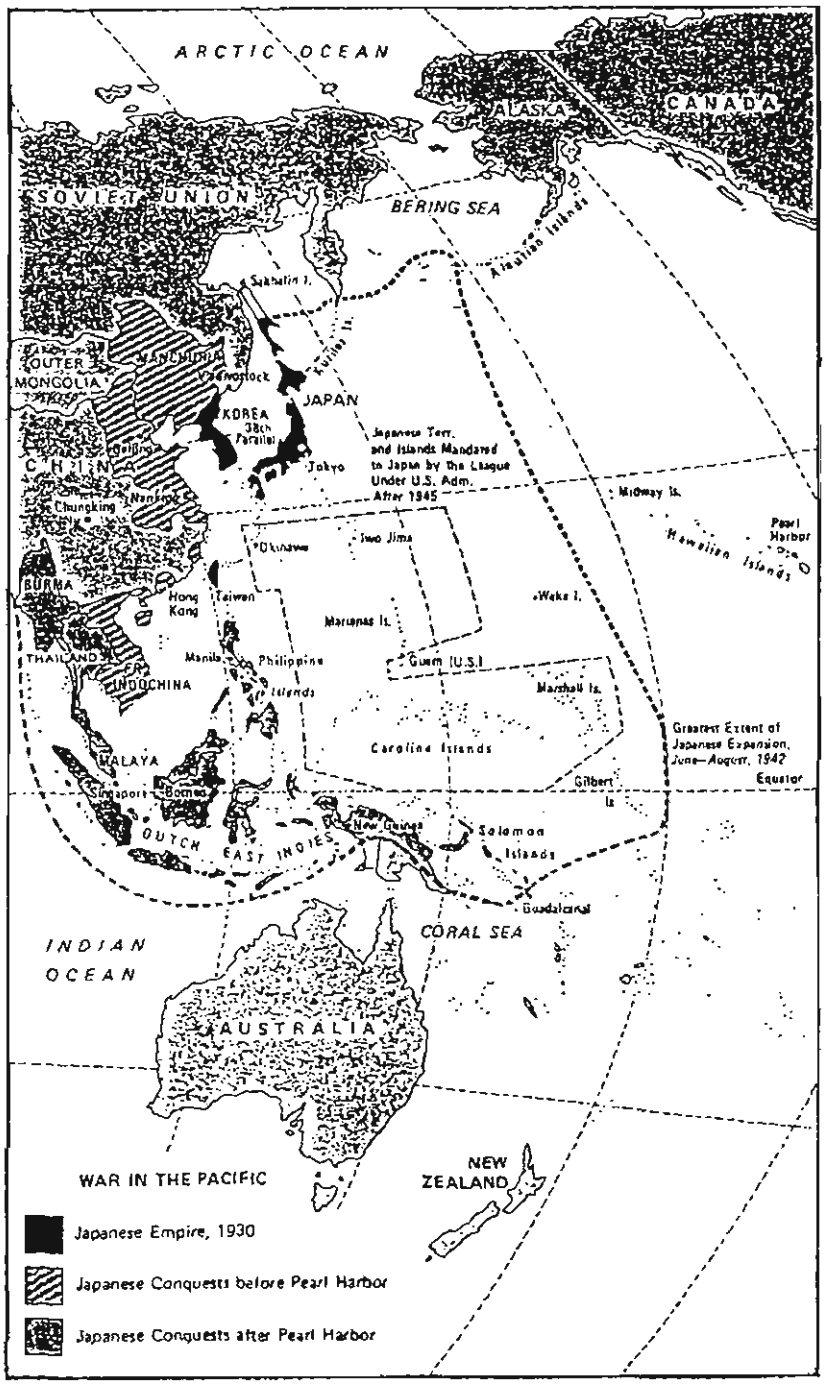
The only other source of information about the maneuvers, in addition to the Sigint described in the following paragraphs, was a letter from an unidentified person on Saipan who saw a squadron of 35 Japanese vessels (cruisers, carriers, and destroyers) engaged in maneuvers for three days. Reportedly over 6,000 naval personnel went ashore on Saipan for a short visit.

Only meager information about this major Japanese fleet exercise was available to the Navy until the Commandant of the U.S. naval station at Guam sent intercepted traffic to CNO Washington on 15 September. He also passed on a report of radio activities for the period covering the Japanese fleet cruise. Two chief radiomen prepared the report and Wenger observed that the report from the station on Guam demonstrated "great possibilities inherent in a mere study of radio traffic as a means of gaining valuable information where ordinary methods fail."[17]

Based on OP-20-G possession of the Japanese Red Code, most of the messages intercepted by Guam were eventually decoded in Washington. It was a revelation! The Japanese maneuver simulated a defense of the western Pacific against the U.S. fleet and involved a complete mobilization of the Japanese fleet, local defense forces, and the shore establishment. The OP-20-G decrypts also revealed Japan's capture of Guam and the Philippines and a mock air raid by American aircraft carriers on Tokyo.[18] Most importantly, however, analysis of the decrypted messages disclosed Japan's knowledge of Plan Orange – the American war plan for the Pacific.[19]

Wenger's report concluded that Japanese DF was very accurate and that they had solved the problem of accurate DF from moving ships. In addition, the Japanese had established DF stations in the Pacific at Bako, Ashizuri, and Hamamatsu.[20] Their military force afloat, combined with a Comint and DF capability, made the Japanese navy a formidable force in the Pacific.

15. Ibid., p. 9.
16. SRH 222, "Report on Japanese Grand Fleet Maneuvers, May–June 1930," Lieutenant J. N. Wenger, dated 22 July 1931.
17. Ibid., p. 4. "Ordinary methods" means cryptanalysis.
18. Layton, p. 35.
19. SRH 222, p. 5.
20. Ibid., p. 23.



Pacific Theater

Even without effective U.S. Navy DF, Wenger wrote that through analysis of the traffic one could identify the flagships and shore stations. He also deduced that radio traffic analysis could determine the enemy's order-of-battle and communications structure. Some of the early and unsophisticated techniques featured identifying increased volumes of communications, signal strength readings, and communications compromises.[21]

Although the maneuvers concluded in mid-1930, the OP-20-G report was not forwarded to DNC until a year later. Wenger explained that the Research Desk was tasked by Representative Hamilton Fish of New York to solve Soviet encoded telegrams.[22] During this period, American authorities became aware of the extensive Soviet intelligence operations conducted in America by the Amtorg Trading Corporation based in New York. Fish subpoenaed over 3,000 of their telegrams and gave them first to the Navy cryptanalysts and then to the War Department. Not one encrypted telegram was ever read, however.[23]

In addition to the problem occasioned by Representative Fish's tasking, Wenger became aware that the Japanese were using a new kind of cipher with eight new keys. The cipher was more complex and considerably different from previous Japanese cipher systems. About 15 percent of the messages were never solved.[24] The U.S. Asiatic Fleet could not afford the luxury of waiting until Washington received the traffic, attempted to decrypt it, and reported the results back to the fleet. New methods were essential if the U.S. were to provide more timely tactical intelligence to its Navy operating in the Pacific. At the same time, the Navy realized that the Japanese Red Code had been superseded by the end of 1930. This new code, called "Blue" by the cryptanalysts, was not recognized by OP-20-G until the fall of 1931. Wenger and Lieutenant Thomas H. Dyer, apprentice cryptanalysts, worked on the code until Wenger was reassigned to the Pacific to take over the radio intelligence organization of the Asiatic Command.[25] It was during this period in the Pacific that Wenger developed the concept of radio traffic analysis and conceived the idea of a major Sigint exploitation effort against the 1933 Japanese maneuvers to demonstrate the intrinsic value of radio traffic analysis.

A SUCCESSFUL EXPERIMENT – THE TURNING POINT

The primary objective of the U.S. Navy's Sigint effort in 1933 was a demonstration of the kind and quantity of intelligence that can be obtained by intercept units in the field through analysis of callsigns, addresses, frequencies, and length of messages without ever

21. Ibid., p. 26. These TA techniques had not changed much from the U.S. Army experience during World War I. One could speculate on how much further ahead the Navy could have been if they had knowledge of the Army's World War I experiences.
22. Ibid., p. 29.
23. Kahn, p. 635. The year 1931 was a significant time for revelations. Herbert O. Yardley's *The American Black Chamber* (Indianapolis: Bobbs-Merrill Co., 1931) revealed the methods by which the Americans had the upper hand in the negotiations among the Japanese, British, and U.S. at the 1921–22 Washington Naval Conference. Yardley was reading the communications between the negotiating team and Tokyo. When revealed in 1931 that the U.S. knew the weakness in the Japanese position through communications intelligence, it caused a furor in the U.S. and Japan. This major security breach undoubtedly precipitated a tightening of Japanese communications and code security which directly affected the Navy's radio intelligence effort in the Pacific during the 1930s.
24. SRH 222, p. 29.
25. Layton, pp. 45–46. Layton calls Dyer the "Father of Machine Cryptanalysis." Dyer enlisted IBM to help sift through possible solutions to the new Japanese code in September 1931.

CAPT Thomas H. Dyer, USN

mounting any attack on enemy codes and ciphers.[26] The testing ground for this effort was the Japanese Grand Fleet Maneuvers of 1933. Lieutenant Wenger's plan was to collect information and produce intelligence in the field. He hoped to demonstrate that the fleet didn't have to wait for Washington to decrypt the messages and report on the maneuvers – which was usually several weeks after the event.

The plan was ambitious but its success proved the value of radio traffic analysis. Wenger's plan was to intercept Japanese communications from a number of shore stations and the USS *Goldstar*, to perform on-the-spot analysis by personnel at the stations, and for the analysts/reporters to forward the "hot" information by radio to CINCAF. Message logs were sent by courier to Wenger aboard the USS *Augusta*, the fleet flagship, which was anchored off Tsingtao, China, during the exercise. Wenger analyzed the traffic to determine how much information could be obtained by methods short of cryptanalysis and the accuracy of this information.[27]

Ground truth was established by sending a copy of the traffic to Washington for decryption[28] of the messages and verification of the traffic analysis performed in the field. The grand success of Wenger's experiment convinced CINCAF of the value of communications intelligence. The CINCAF, Admiral Frank B. Upham, took the lessons seriously and recommended to Washington the creation of a major survivable intercept unit in the Manila area which would operate without interruption in the Ultimate Defense Area during a war in the Pacific.[29]

The maneuvers of 1933 and their successful exploitation by the Navy was the turning point in the fortunes of communications intelligence and determined the fate of traffic analysis in the field for many years to come. The Navy was sold on the concept which it nurtured and developed throughout the period between the wars. Signals intelligence, cryptanalysis, and traffic analysis became the bulwarks of the Navy's intelligence effort against the Japanese during the Second World War. Without the experiment of 1933, the Navy would have been much less prepared to take on the Japanese in 1941 and 1942 when its back was against the wall in the Pacific.

THE COMINT EXPLOITATION OF THE 1933 MANEUVERS

The 1933 maneuvers followed the magnitude and general pattern of the 1930 Grand Maneuvers and confirmed the Navy's belief that they were a rehearsal of the Japanese war plans. By 1933, Lieutenant Wenger, aboard the USS *Augusta*[30] and head of radio intelligence for the Asiatic Fleet, had 36 men, all of whom were to participate in the exploitation experiment. (In 1930, the Navy's Comint organization in the Pacific was one-fourth the size.)

26. SRH 223, "Various Reports on the Japanese Grand Fleet Maneuvers June–August 1933," p. 2. This SRH contains Wenger's report from the USS *Augusta* to CNO dated 7 March 1934. This report is probably one of the most important historical documents in the development of U.S. signals intelligence and radio traffic analysis.
27. SRH 355, p. 118.
28. Ibid., p. 119. The Blue Book Codes had now been partially solved, i.e., about 50 percent of the messages intercepted were being read.
29. Ibid., p. 122. The intercept station at Corregidor was captured by the Japanese in 1942.
30. The USS *Augusta* was the ship on which Roosevelt and Churchill met for the first time in August 1941 off Newfoundland. They forged the Atlantic Charter declaration and agreed to a strategy on how they would fight a World War as allies.

CAPT Joseph N. Wenger, USN

In 1933, Wenger's men were scattered throughout the Pacific: on the USS *Gold Star*,[31] at Guam, at Olongapo in the Philippines, and at Beijing.[32]

While the U.S. operators could now copy the Japanese Kana code, in Wenger's words, "they failed to appreciate, for example, the possibilities of acquiring intelligence through such secondary means as calls(igns), addresses, frequencies, transmitter tones, operators' peculiarities, and other similar indirect or incidental manifestations."[33] In anticipation, Wenger arranged for the intercept operators to be trained before the 1933 maneuvers in basic traffic analysis. This was the beginning of radio traffic analysis "in the field" for the Navy, and since it contributed directly to fleet operations, it soon became known as combat intelligence. The Navy's first traffic analysts also doubled as collection operators or clerks supporting collection operations.

Wenger sent his assistant, a chief radioman, to the Philippines in June to help prepare the intercept unit at Olongapo. (Before he arrived at the unit, while sailing from China to Manila, he spent time aboard the USS *Sacramento* in mid-June intercepting Japanese operational communications.) Wenger also arranged for all the units to receive important collateral information (from the naval attaché in Tokyo) about the Japanese Fleet.[34]

OBJECTIVES AND ASSIGNMENTS

While the main purpose of the effort in 1933 was to prove the value of the new techniques, there were other equally important objectives:

- To simulate war conditions.
- To intercept the maximum amount of Japanese traffic for the cryptanalysts.
- To determine potential weaknesses in the Japanese communications system.
- To determine weaknesses in the U.S. Navy intercept organization.
- To provide information for the building of a modernized Comint organization.[35]

Wenger's intercept, analysis, and reporting organization was assigned specific frequency ranges and geographical areas to cover for the exercise. Although he had no operators or clerks aboard the *Augusta* to follow the exercise, he assigned tasks and resources to the other stations as follows:

31. The USS *Gold Star* was the station ship at Guam which made periodic cruises to Manila and the China coast carrying a limited number of dependents for rest and recuperation after a long stay on the island.
32. SRH 223, pp. 13–14.
33. Ibid., p. 10.
34. Ibid., p. 12.
35. Ibid., p. 2.

Station	Assignment	Personnel
USS *Gold Star*	Internal fleet freqs Frequencies measurements, DF	3 intercept ops & 1 CRM (chief radioman)
Guam	Internal fleet frequencies HF above 6,000 kcs Chichijima LF, HF Yokosuka LF Saipan HF Frequency measurements, DF	10 ops & 1 CRM
Olongapo	Fleet HF (below 6,000 kcs) Hozan LF Bako LF Palao HF Frequency measurements, no DF	10 ops & 1 CRM
Beijing	Any maneuver traffic, no DF[36]	9 ops (marines) & 1 CRM

THE EXERCISES AND THE COMINT OPERATIONS

The reconstruction of the Japanese fleet by Tokyo in 1933 laid the foundation for the organization of its strike forces eight years later in the Pacific. (In the early summer of 1941, the Japanese added the Fifth Fleet and located it in the Kurile Islands.) In the 1933 maneuvers, four fleets were mobilized and organized along the following lines: The First and Second Fleets escorted troop transports and covered operations of the Combined Landing Force; the Third Fleet maintained its station along the China coast and up the Yangtze River; and, the Fourth Fleet (created permanently during the exercise) took over duties of a "home defense fleet" from First Fleet. The First Fleet was now available for more aggressive actions.[37]

It was apparent from the Comint that the Japanese divided the maneuvers into four distinct phases:

1. Mobilization – 17 May to 12 July.
2. Strategic – 13 July to 14 August.
3. Tactical – 15 August to 19 August.
4. Critique and fleet review by the emperor – 21 August to 25 August.[38]

The concept of the maneuver during its strategic phase required the First and Second Fleets to hold or capture territory in the western Pacific including the eastern coast of China, the Philippines, and the Marianas. The Japanese estimated that the U.S. fleet would steam westward from Pearl Harbor, attempt to recapture Guam, and attack

36. Ibid., pp. 13–14.
37. SRH 356, pp. 119–120.
38. Ibid., p. 120.

Japanese bases in the Marianas. During this tactical phase of the exercise, the First and Second Fleets became the Blue Fleet and represented the U.S. resurgence. The Fourth Fleet, personally commanded by the emperor, was known as the Red Fleet and defended the Japanese homeland and its new territories as the Combined Fleet.[39]

Analysis during the exercise disclosed that the maneuvers were, among other things, a rehearsal for future invasions by the Japanese in the Far East. During the exercise, the Third Fleet blockaded Chinese ports against possible American interference; in 1937, this fleet covered and assisted landing forces in China during the Sino-Japanese War.[40]

Before the maneuvers actually began, Wenger worked out the Japanese radio operating plan by the measurements of frequencies used. In his words, "The frequency plan thus revealed led to determination of the chain of delivery or command. This provided a basis upon which to establish identification of secret calls and addresses."[41] By means of frequency usage, it was possible to establish if not the exact identity, at least the type represented by the other callsigns during the maneuvers.

The first indications of mobilization appeared in Japanese traffic in February 1933. New, secret callsigns were intercepted. In March, the intercept unit on Guam reported a sudden change in the operating ability of the radiomen of the primary stations at Tokyo and Sasebo – new and inexperienced operators were being placed on the circuits. On 17 May, both Olongapo and Guam detected changes in the normal fleet organization. The names of certain units of the First and Second Fleets were changed and the new Fourth Fleet was created. By the middle of June, Guam was able to give an extraordinarily accurate picture of the entire organization of all Japanese naval forces. The most significant change was the creation of a new fleet from ships ordinarily held in reserve.[42]

Intercept from Beijing was not voluminous but it was significant. Traffic intercepted from northern China arrived in about three weeks at CINCAF's Headquarters aboard the USS *Augusta*. Wenger worked out the secret calls of the Third Submarine Squadron which helped him understand the entire system. The station at Olongapo worked out independently the basic solution to both the secret callsign system and the address system in about a week from the start of the exercise. Traffic analysis was aided by undisciplined Japanese operator compromises. The analysts discovered that the callsign lists were arrived at systematically and followed the administrative or tactical organization of the fleet.[43]

The analytic work during the exercise stressed the importance of carefully filing and indexing information to permit rapid reference. All collateral (organization lists, geographical data, facts acquired by previous intercept activity) was arranged beforehand and made available to each station. The stations' indexing of exercise traffic was detailed: Each transmission was scrupulously noted by date, time, station called, station calling, message serial number, address, origin and page number of the traffic. These basic records became indispensable to analysis.

All callsigns were card-indexed. For each call, each card showed the calls communicated with, the number of transmissions, and the frequencies used. These records formed the basis of net reconstruction; that is, the callsigns were arranged by frequencies, and thus nets were deduced. In addition, a chronological record was prepared of DF shots and any radio schedules.[44]

39. Ibid., pp. 120–21.
40. Ibid.
41. SRH 223, p. 17.
42. SRH 355, p. 120.
43. SRH 223, pp. 17–18.
44. Ibid., p. 19.

Wenger was convinced this effort was worth the price. He proved his concepts, for he was ultimately able to demonstrate successfully the value of traffic analysis, the importance of combat information to the fleet, the use of Comint to warn of potential hostilities, and the potential for exploitating exercises to learn an enemy's war plans.

CONCLUSIONS AND RECOMMENDATIONS FROM 1933

> The Orange secret maneuvers of 1930 were analyzed through decryption of the ciphers employed. Here (1933) an effort has been made to obtain the same and by attack from an entirely different angle. In time of war it is to be expected that codes and ciphers normally used by the enemy will be changed at once. Even if the new cryptographic systems can be successfully solved, the task of breaking them down will require days, if not weeks, to accomplish. Until this is done the flow of intelligence will be stopped and stopped during the critical period of the commencement of hostilities when the plan of campaign is being laid and information concerning the enemy is essential to success.
>
> Codes and ciphers may be changed readily upon the outbreak of war. However, the communications system or method of handling traffic, which has taken years to evolve and perfect cannot be so easily superseded. It is upon this hypothesis that the foregoing study has been made. That the communications system alone can be a source of valuable intelligence, this analysis, it is believed, has definitely demonstrated. The intelligence to be expected from this source is chiefly of a strategic nature. If properly and skillfully exploited, it can provide information essential to a correct estimate of the situation. This being true, radio intelligence activities are vitally important in time of peace, especially where strained relations exist.[45]

In addition to the above conclusions, Wenger made a number of recommendations to CINCAF which were forwarded to Washington for action. Some of them had been heard previously, but now there was ample basis for the Navy to take heed. Recommendations 3 and 6 cited below were the genesis of radio traffic analysis training in the Navy. Recommendation number 1 was the basis for establishing a Comint unit at Corregidor, and number 2 provided the impetus for the development of effective DF in the Navy.

1. Locate at least one intercept unit in the ultimate defense area so that it can function without interruption upon the outbreak of the war.
2. Equip all stations with suitable long range direction finding apparatus and the best obtainable receivers.
3. Train all operators in the proper coordination of DF and frequency measurement with traffic interception for the deduction of intelligence by the methods in the report.
4. Provide sufficient intercept operators to coordinate the three phases of intercept work.
5. Establish a decrypting center in connection with, or in the vicinity of the intercept station in the ultimate defense area.
6. Provide at least two cryptanalysts, one translator, and two clerks for the analysis of intercepted material.

45. Ibid., p. 29.

7. Conduct intercept activities on the Asiatic station in time of peace not only with the idea of studying the Orange communications system, but with the more important mission of preventing surprise attack.
8. Continue the policy of preserving the utmost secrecy concerning intercept activities in order to protect the source of supply of radio intercept.[46]

THE MANEUVERS OF 1934 AND 1935: MORE CHALLENGES

There were still more challenges to be met and overcome during the years directly before Pearl Harbor. The Grand Fleet Maneuvers of 1934 posed two major problems for the U.S. Navy: the employment of stringent security measures by the Japanese and the proximity of the maneuvers to the Japanese home territory. The 1934 maneuvers were not as ambitious in scope as those of the previous year, and the Japanese realized the need for additional security to deny the U.S. Navy information concerning the activities of their fleet.

The Japanese emphasized three areas to improve their communications security from 1933: regulation of power and frequency, shifting frequencies, and changing callsigns and addresses. In 1934, the Imperial Fleet employed many more frequencies in the same ranges and decreased their power whenever a main shore station cleared traffic directly to the fleet. The use of the HF range was sharply curtailed, and the fleet tactical units maneuvered near to shore rather than in open waters where they could be observed by the U.S. Navy.[47]

During the exercise, U.S. Navy Comint units intercepted the Japanese sending a message on one frequency and shifting to another frequency in the middle of a transmission. The U.S. operators believed the Japanese were employing some automatic method of doing this since no frequency shift alert was given to the receiving station.

Moreover, the Japanese did not assign permanent callsigns and addresses to stations as in previous years. In addition, they no longer assigned similar secret calls and addresses to similar vessels. Callsigns and addresses were apparently a combination of different types, and they were changed at frequent intervals. Each vessel and command was assigned one secret call to be effective for one month or less. Flagships used separate callsigns for each frequency and addresses were changed simultaneously with the callsigns. Secret callsigns were apparently assigned at random.[48]

Although only a meager amount of traffic was monitored during the exercise, the U.S. Navy intercept and analytic effort was able to inform CINCAF of the immediate location of the main Japanese naval forces. Regardless of this success, the intercept war had clearly been balanced through the Japanese denial practices in 1934. They realized the potential for signals intelligence and took action to deny the U.S. Navy combat information. In addition to the increased communications security, the Japanese employed effective DF and were able to regularly locate the USS *Augusta*, the CINCAF flagship.[49]

46. Ibid.
47. SRH 224, "Various Reports on the Japanese Grand Fleet Maneuvers August–October 1934," dated 28 February 1935, p. 7.
48. Ibid.
49. Ibid., p. 9.

In 1935, the success of the U.S. Navy effort was not any better than in 1934. The Japanese employed broadcasts to alert their fleet and new secret callsign and address systems were introduced. Encipherment increased and the Japanese, according to a Humint report, introduced a new radio transmitting at 120 mHz.[50]

THE LEVEL OF TRAFFIC ANALYSIS BEFORE WORLD WAR II

The increase in effectiveness of Japanese communications security practices in 1934 and 1935 succeeded in denying some communications intelligence information to the U.S., but the Navy continued to refine its techniques in the Comint-Comsec "battles" of the mid- and late 1930s. Japanese naval operations associated with the Fleet Maneuvers of 1936 were once again minor compared to the very large exercises of 1930 and 1933. The Japanese were involved in occupation duty in China and their economy could not support extensive fleet exercises. Consequently, there was little opportunity for the U.S. Navy to intercept intra-fleet communications; all the information about the exercise came from the radio traffic from the shore stations and the flagships.

Despite the situation, the Comint organizations were able through traffic analysis to locate the main body of the Japanese fleet, to predict accurately proposed fleet movements and to provide CINCAF with 15 to 30 days warning of the Japanese fleet mobilization.[51]

Some of the problems associated with exploitation of the exercise are best illustrated by the following report from the U.S. Navy intercept station in the Philippines:

> A sufficient number of calls were identified to enable this activity to keep an almost constant check on Fleet maneuvering activity. However, during the period of this maneuver the value of secret calls was continually brought to (our) attention. Following a Fleet that is using secret calls is an entirely different one from following a Fleet using service calls of common knowledge. It was not found possible for the average operator to identify secret calls of forces afloat from key notes or operator characteristics, and it is the firm conviction of this activity that much that has been said in the past relative to the ease with which secret calls can be identified is in error. Of course if the transmitting operator slipped and mixed in service calls, identifications were instantaneous but such errors were rare. Such identifications as were made of individual vessels were obtained after many hours of research and checking. It was noted that one or more units of a force would shift calls and the remaining units therein would not shift. It was proven beyond any doubt that Orange uses secret calls only when engaging in tactical exercises. When the Fleet cruises, service calls are used.... No identifications whatsoever were made of the secret addresses.[52]

50. SRH 225, "Various Reports on the Japanese Grand Fleet Maneuvers, July–September 1935," pp. 9 and 67–68. SRH 355, pp. 157–59. In a memorandum from Commander McClaran, OP-20-G, to DNC dated 23 September 1935 on the subject of communications intelligence research, McClaran stated: "Research work has led to a study of radio intelligence, esepcially the possibilities of analyzing intercepted radio traffic and from such analysis obtaining vital information of fleet organization, operations, movements, and plans. Through actual test it has been conclusively proven that all of the above can be done without the aid of any decryption, and, furthermore, that much of this analytical work can be done by specially trained intercept operators. This is a new discovery; it is a discovery that will be of vital importance to the Fleet and the High Commands afloat."

51. SRH 318, "U.S. Navy Reports on the Japanese Grand Fleet Maneuvers 1936," dated 13 March 1937, p. 1. The main source is from CINCAF (on the USS *Augusta*) to CNO dated 13 March 1937. By this time, the unit in the Philippines had a cryptanalytic capability. During the exercise, the Japanese CINC Combined Fleet sent 76 messages. Fifty-four were intercepted by the station and 45 were decrypted and translated. The report was signed by R. S. Lamb.

52. Ibid., p. 202.

The U.S. Navy Comint analysts had not solved the entire Japanese callsign or address system in 1936, but they were able to identify some of the callsigns and associate them with a particular ship at times. The main source of information for the U.S. Navy was Japanese operator compromise. Other techniques used by the Navy were association of a secret and a service call on the same frequency, unusual procedures associated with a particular ship, reuse of a serial number suffix, collective calls answered in error, and the volume of traffic originated and handled by the flagships.[53]

Despite the mixed success of these rudimentary traffic-analytic techniques, the Navy learned the value of keeping detailed records of traffic. Its final report of the 1936 maneuvers included a description of each communications circuit under the following parameters: frequency usage, procedures, schedules, use of code/cipher, relays, hearability, use of power, operator expertise, method of U.S. reception and quality, callsign identification, chronological description of the communications system and the activity of the correspondents. The Navy drew very complete net diagrams and published and disseminated them to all the Comint units in the Asiatic Command.[54]

The final report observed that a "maneuvering code separator" between message groups indicated a different key in enciphering. The report also displayed the kinds of messages sent, a study of message volumes, a study of the message serial number system, and a compilation of weekly traffic volumes by station and by frequency.[55] The Navy continued the development of TA techniques right up to the start of World War II. However, more significant and certainly more crucial advances would occur during the war itself.

53. Ibid., pp. 264–65.
54. Ibid., pp. 206–07.
55. Ibid., pp. 275–359. SRH 355, pp. 213–15. The first recognized traffic analyst may have been assigned to the station in the Philippines about 1936–1937. The station listed the following personnel:

1 officer-in-charge
3 yeoman cryptanalysts
1 radioman traffic analyst
1 radioman translator
1 radioman researcher
1 chief radioman (for HFDF)
12 intercept operators.

SRH 355, pp. 230. By 1937, each major security group station had two traffic sections (one for preparation and one for analysis), one information section, one section each for cryptanalysis, decryption, and translation.

EPILOGUE

American radio traffic analysis materialized during the Navy's exploitation of the Japanese fleet exercises of the 1920s and 1930s. Its Comint organization was at war with the Japanese naval communicators during those years of challenge in the Pacific. The absence of readily available decryptions of Japanese enciphered traffic was the impetus for traffic-analytic developments.

The U.S. Navy acknowledged the value of timely combat intelligence and discerned that radio traffic analysis was the main source of timely intelligence about operational Japanese fleet activities. The groundwork was laid in the period between the wars for the vital contribution of traffic analysis to the eventual victory in the Pacific.

(U) A summary of [redacted] professional background appears in the Spring 1987 issue of the *Cryptologic Quarterly*.

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